

# Nitramine Explosive (RDX) Degradation by Electrooxidation on Platinum and Lead Dioxide Anodes

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Nowadays, there is a great concern in relation to contamination of the environment. The hexahydro-1,3,5-trinitro-1,3,5-s-triazine (RDX) is the most commonly of the explosives that enter the environment through the manufacturing process or improper handling and disposal methods. Besides, this compound is very used in the production of bombs and ammunition. RDX is very slowly decomposed in the environment, thus it could contaminate the soil and the underground waters. Thus, it is important develop treatment methods to eliminate this pollutant from the environment. The main aim of the organics degradation is its conversion in non-toxic products. An alternative for degradation is the use of the electrochemistry techniques. The electrooxidation of many organic compounds has been widely studied<sup>1-3</sup>, although nothing was found regarding the electrochemical oxidation of the RDX. The efficiency of this process depends on several parameters, as electrode material, pH, applied potential, initial concentration of organics, etc.

In this work the electrochemical oxidation of RDX was investigated in acid (H<sub>2</sub>SO<sub>4</sub> 0,05 M) and neutral (Na<sub>2</sub>SO<sub>4</sub> 0,05 M) solutions, at room temperature, by potentiostatic electrolysis in 1.6 V and 1.7 V vs. MSE on platinum and lead dioxide, respectively. The electrolysis time was ca. 2 h. The electrolysis efficiency was accompanied by following the concentration decrease of the RDX and the concentration increase of the main product formed. The kinetics of the oxidation process was also studied in this work.

A platinum sheet (1.0 cm<sup>2</sup>) and lead dioxide electrode deposited on platinum (1.0 cm<sup>2</sup>) were used as working electrodes. The counter electrode was platinum and the MSE system was used as the reference electrode. The electrolytic solutions were prepared with p.a. grade H<sub>2</sub>SO<sub>4</sub> and Na<sub>2</sub>SO<sub>4</sub>. The initial concentration of RDX was 0.02 mM.

The electrochemical studies were done in a two compartments glass pyrex cell, separated by a Nafion membrane with the propose do not allow the mixture of the solutions contained in the anodic and cathodic compartments.

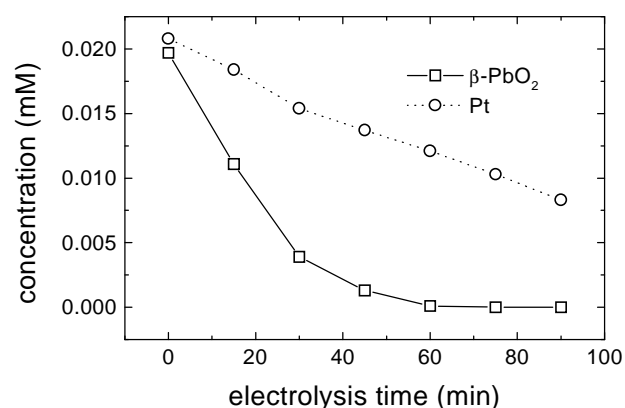
Analyses were carried out by HPLC using a C18 column ( $\lambda$ =210 nm) that has been employed to monitor the decrease of RDX concentration and the formation of the main observed product during the electrolyses.

The results concerning the RDX electrooxidation using platinum electrode in H<sub>2</sub>SO<sub>4</sub> 0.05 M showed that after one hour of electrolysis ca. 99% of RDX was oxidized. After 1.5 hour it was not verified the presence of this organic in solution, due the complete disappearing of the RDX chromatograph peak indicating thus, it completes degradation. The results obtained using lead dioxide electrode and H<sub>2</sub>SO<sub>4</sub> 0.05 M indicated that after 1 hour of electrolysis ca. 99% of RDX was oxidized. For both electrodes was observed Na<sub>2</sub>SO<sub>4</sub> at 0,05 M decreases the electrolyses time of total degradation RDX. After 45 minutes was not observed the presence of RDX.

Additionally, in all experiments we observed from the chromatograms the formation of a product, probably the formamide, that later also was oxidized, because after 2 hours of electrolysis the relative area to this pick decreased the total disappearance even almost. The Figure 1 shows the decreasing of RDX compound for two electrodes using H<sub>2</sub>SO<sub>4</sub> as support electrolyte. From this Figure is possible to observe that lead dioxide oxidizes more RDX than platinum electrode using the same experimental conditions.

The electrooxidation has been shown viable for studying of the organic oxidation, through these studies are still basic and with a purpose in technological application it will be necessary optimize the experiments. The RDX electrooxidation showed better efficiency than phenol degradation<sup>3</sup>, indicating that the initial concentration and the reactivity of the organic compounds are decisive factors for the efficiency of this process.

The use of Na<sub>2</sub>SO<sub>4</sub> was better than H<sub>2</sub>SO<sub>4</sub> in the total RDX electrooxidation as well as the lead dioxide electrode showed to be more efficient than platinum electrode.



**Figure 1.** Evolution of RDX decreases for lead dioxide electrode and platinum electrode. H<sub>2</sub>SO<sub>4</sub>: 0.05 M,.

## References

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